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## *STUDIES FOR STUDENTS.*

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### JAMES D. DANA AS A TEACHER OF GEOLOGY.

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To sit at the feet of Professor Dana and drink from the overflowing fountains of his knowledge, was a privilege which once enjoyed could never be forgotten. One knew not which to admire most, the simplicity and nobility of his character, or the breadth and grasp of his intellect. Yet none could fail to be impressed with the fact that one was the complement of the other. Had he been less keen, thoughtful, impartial, he would have been less admirable as a man. Had he been less sincere, unselfish, truth loving, he would have accomplished less as a scientist.

Unconsciously but irresistibly as he taught geology, he revealed to his students his own character, and all which he revealed made them long to know him more deeply and truly. He imparted to them too, unconsciously I have no doubt, the principles of the successful pursuit of knowledge and the methods by which progress in science is attained which had enabled him to accomplish Herculean tasks in the same direction and to occupy the prominent place which he did among the scientific workers of his time.

Glancing over the notes of his talks which I made during the two years that I was privileged to study under his instruction, I find many aphorisms which he let fall indicating the methods by which his own success in scientific work was attained. Thus, when stating the different theories which had been proposed regarding the mode of formation of coral islands, he expressed a wish that borings might be made so as to learn on what foundations the islands rest, remarking, "When I get at a thing I want to go to the bottom of it and then I am willing to leave

it." The remark reminds one much of the answer given by Lincoln to a question as to how he gained so clear a knowledge of the subjects with which he dealt, when he said: "I cannot rest easy when I am handling a thought till I have bounded it upon the north, upon the south, upon the east and upon the west."

Another maxim which it would be well to keep in mind in these days of easy publication Professor Dana gave utterance to when, in referring to some of the theories which were being advanced at the time to account for the subsidences of the earth's crust, he said: "I think it better to doubt until you know. Too many people assert and then let others doubt."

The same judicial poise was exhibited in his readiness to change his former opinions when he became convinced that the evidence was sufficient to warrant it. Absolute candor and desire to support only the truth as he saw the truth were among his principal characteristics, and he sought constantly to impress upon his students their importance as factors of success in the pursuit of knowledge.

Thus in studying the Cambrian era, which the labors of Walcott and others at that time had shown to be of far greater extent and importance than had previously been supposed, his students were told to regard it as of equal importance with the Lower Silurian, though in his text-book it was one of the subdivisions of the latter, and his remark at the time was: "I have found it best to be always afloat in regard to opinions on geology."

So too in accepting as divisions of independent continental progress, the Eastern Border, Eastern Continental, Interior Continental, Western Continental and Western Border regions, a classification which differed from that which he had previously made, he said: "I always like to change when I can make a change for the better."

In adopting views which had been originated by others, he never sought to assume from them any credit to himself, but freely gave honor to whom honor was due. This was well illustrated in his espousal of Darwin's theory of the formation of

coral islands. It was a subject to which before the publication of Darwin's views he had himself given much thought, without arriving in his own mind at any satisfactory hypothesis. "As soon as Darwin published his theory, however," said he, "I saw at once that it solved the difficulties of the case," and though he did much to expand and verify it, he never claimed it in any degree as his own. His change of opinion regarding the theory of evolution is likewise well known, and he never hesitated to mention it in his lectures upon the subject.

Upon those, however, who sought to gain scientific repute by any other means than a careful and unbiased study of facts, his strictures were severe. One geologist of some prominence he described as "a man of wonderful resources, because he had only to go to his own brain for facts," and his students were often warned against accepting any of such an observer's conclusions.

Woe likewise to the student who sought to conceal the bubble of his ignorance with a thin varnish of words. The bubble would be pricked with a celerity and suddenness that left no desire for a repetition of the experiment.

No man, however, was ever more ready, even eager, to assist those who wanted to obtain knowledge. While he had no time to waste on those who studied geology only as a matter of form, his resources were freely at the disposal of any who displayed intelligent interest in the subject.

One way in which he evinced this was by the long walks which he was wont to take with his students about New Haven, or other trips to places more distant. Though these were over the same ground year after year, he never seemed to weary of the journey so long as his students showed any desire to be instructed by what they saw. Even to the very last of his life these trips were continued, the teacher of nearly fourscore years traveling over rocky steeps and through brambly thickets with all the ease and sprightliness of youth and at a pace which his younger followers found difficult to imitate. The number and variety of illustrations of geological principles which he could point out in such walks of a few hours were indeed remarkable,

and taught his students that they need not go to distant parts of the earth to make geological observations, for they could find material sufficient for study at their own door. The trap ridges, kettle holes and boulder trains of the vicinity of New Haven have thus become of classic interest, not because they presented any unusual features, but because Professor Dana resided near them, studied them, and gave to the world the results of his observations.

No operation that was carried on within the range of his observation, the details of which could add to the sum of geological knowledge or help solve any of its problems, seemed to escape his notice. Every railroad cut, every survey, every excavation and every boring he carefully watched and gained from them facts which helped him interpret the past history of the earth.

The bricks which were burned in the Quinnipiac kilns he had analyzed in order to learn why they fused so easily, and gained thereby important information regarding the source of the clay. By the dolomitic blocks of the State House he illustrated to his classes the principles of the disintegration of limestone, and by the granite pillars of the Peabody Museum the expansion of stone by heat. From watching the drying of a drop of milk on a stone floor he derived an explanation of the forms produced by concretionary consolidation, and by experimenting with varieties of sand dropped about an upright darning needle established the principles governing the angle of rest for falling detritus.

His ability to retain in his mind various phases of geological evidence, and develop them as time progressed, was likewise remarkable. Thus, in 1889, in his teaching he laid much more stress on the influence of the Cincinnati uplift in determining the character of the rocks of the interior of the continent than he had previously done in his Manual, for he said he had never so fully realized its importance as he had that year.

Nor were his students compelled to receive obsolete theories or time-worn illustrations because he had held or used them

in the past. On the contrary they were kept informed of the newest discoveries and latest phases of geological thought and urged to judge for themselves of their importance and bearing upon previously attested principles. With all the varied lines of thought and discovery he kept in closest touch, and seemed equally appreciative of their value, whether they related to the eruptions of Kilauea, the Algonkian formation, Mesozoic mammals, the causes of oscillation of the earth's surface, or what not. Of this progressiveness and appreciation of all additions to the sum of geological knowledge his newly published Manual gives sufficient evidence.

The quality in an investigator which, other things being equal, he seemed to esteem most highly, was that of *carefulness*. How often were his students advised to trust or to doubt the statements of an author according as he was or was not, in the opinion of Professor Dana a *careful* man. With hasty and ill-considered conclusions or elaborate theories built from meager observations he had no patience, but to opinions which he believed had been derived from a careful and thorough study of facts, he was ever ready to give the fullest consideration, however much they might be opposed to his previous conclusions. "More," he said, "could be learned by studying unconformities than conformities," and this he believed to be as true of unconformable opinions as of heterogeneous strata.

The awakening in his mind of the interest in science which became the ruling passion of his life, and led to his signal achievements for its advance, Professor Dana used to ascribe largely to two causes, one that of having spent much of his early life in the country, the other, his first teacher. In connection with the first he used to deplore the lack of development of the faculties of observation and the ignorance of nature consequent upon life in the city and placed a high estimate upon the education unconsciously gained by an association with the beings and phenomena of the natural world. As an illustration of this the author recalls an occasion when having passed in vain nearly around the class for a statement of the differences between a moss and a phenog-

amous plant, Professor Dana turned to one of the few remaining who had not confessed their ignorance, with the remark, "You are from the country, you ought to know." And he did.

Professor Dana's first teacher was an ardent student of nature who was wont to go with his pupils on long tramps for the purpose of collecting minerals, plants and insects, and aroused in them much of his own eagerness for the pursuit of knowledge. It is therefore but just that some of the fame of his distinguished pupil should be attributed to him. One incident which Professor Dana used to relate to illustrate his teacher's fervor as a collector was that when on one occasion his little party had gathered at a remote place more mineral specimens than they could carry in their hands, the master, in preference to leaving any behind, improvised a bag from a pair of trousers and thus bore them safely to their destination.

To rehearse at this time the principles of geology which Professor Dana taught, or to state the opinions which he gave to his classes upon mooted geological questions of the day, would be quite superfluous, since they have been sufficiently expressed in his recently published *Manual*, a work fortunately completed just before his death and which came, as another has said, as "the worthy consummation of a long life of exceptional earnestness and success as author, investigator, editor and teacher."

But lest, in contemplating the splendor of his principal achievements, the sidelights which revealed the man and his methods should pass unheeded, it has seemed to me desirable to fix and record them for the encouragement and guidance of those who may desire, however humbly, to follow in his footsteps. There can be no doubt that with him the tenth muse was work, in whose wake the other nine followed, yet the union to this capacity for almost unlimited labor, of breadth of mental vision, calmness of judgment, fertility of resources, strict integrity and loftiness of purpose, did much to render it effective, and enable him to accomplish more than perhaps any other man of his time for the advancement of American geology.

OLIVER C. FARRINGTON.